Rapid Quality Control Of Potato Chips Using Near And Mid Infrared Spectroscopy

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ABSTRACT

Potato chips are the most important product among all the snack industry. Quality of potato chips is monitored by their moisture content and fat content. Traditional methods are reliable, but also time consuming and expensive. The feasibility of developing a methodology for a reliable, sensitive and fast quantification of moisture and fat in potato chips by using infrared spectroscopy combined with multivariate analysis was investigated. Commercial potato chips (16) were obtained from a local market. Samples were grinded and their spectra collected using an integrating sphere (NIR) or attenuated total reflectance (MIR). Calibration models were developed to predict the content of fat and moisture in an independent set of samples. The total fat content ranged from 18% to 45% and the moisture content ranged from 1.2% to 4%. The correlation coefficients (r) obtained for the prediction model of moisture were >0.97 and standard error of cross validation (SECV) < 0.3% for both NIR and MIR techniques. For the prediction model of fat, we obtained r >0.96 and SECV values of 1.29% and 1.65% for NIR and MIR, respectively. Classification models developed based on Soft Independent Modeling of Class Analogy were able to differentiate the potato chips according to type of oil in which the potatoes were fried. The MIR spectroscopy was able to identify samples containing -trans fats at 965 cm-1. A fast, simple and accurate method to evaluate potato chip quality was developed by infrared spectroscopy, providing the industry a convenient technique for routine analysis of the product.

INTRODUCTION

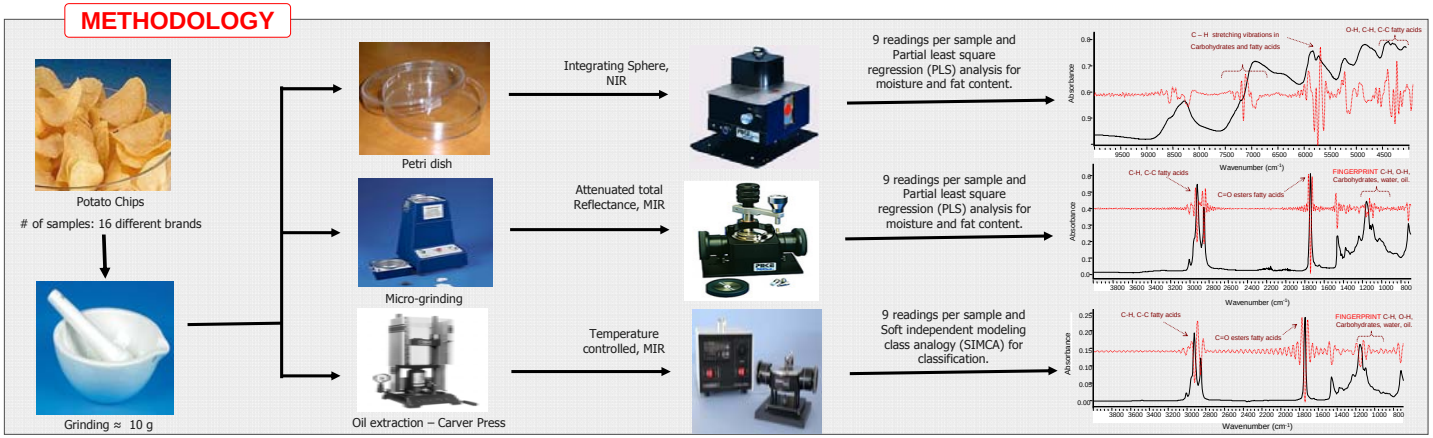
Potato chips are considered as one of the most favored snacks, represented by over the $3 billion spent by Americans, in about 958 million pounds of this product each year. Two common parameters controlled to monitor the quality of potato chips are the moisture content and fat content. The snack industry is looking for analytical techniques that will reduce the time and complexity of current analytical methods for moisture and lipid determination. Infrared spectroscopy is simple, cost-effective, rapid, non destructive and have the potential for routine analysis if proper calibration and validation procedures are applied. Therefore this technique is an appealing alternative for traditional methods.

Infrared spectroscopy is a common technique used to identify compounds based on the property of molecules to absorb the infrared light and experience a wide variety of vibrational motions characteristic of the composition. Near infrared (NIR) is easy to operate, adapt to plant conditions and does not require skilled personnel; in addition, it provides compositional information in few seconds with minimal or no sample preparation. Advantages of the application of NIR in process control include that it is less affected by the presence of moisture and carbon dioxide, improving the signal of the spectra. Mid infrared (MIR) can be applied to small amounts of sample and it is characterized to be a thousand times more sensitive than near infrared, providing fingerprint information about the chemical structure/composition of food samples.

OBJECTIVES

- Development of a fast and accurate method to measure Moisture and Fat and by NIR and MIR spectroscopy AND Multivariate analysis.
- Classify the potato chips based on the oil in which they were fried, as a way to ensure that industries label correct information.

METHODOLOGY



RESULTS

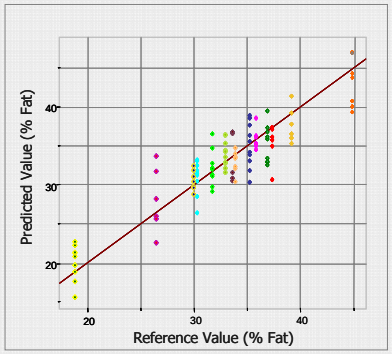


Fig 1. Regression for Fat Content Prediction - MIR

Table 1. Fat and moisture content of Potato chips

Component	Range
Fat (%)	18 - 45
Moisture (%)	1.2 - 4

Table 2. Coefficient values for predicted models

Method	Fat			Moisture		
	# Factors	SEV	rVAL	# Factors	SEV	rVAL
NIR	8	1.294	0.977	12	0.282	0.969
MIR	10	1.65	0.963	11	0.297	0.962

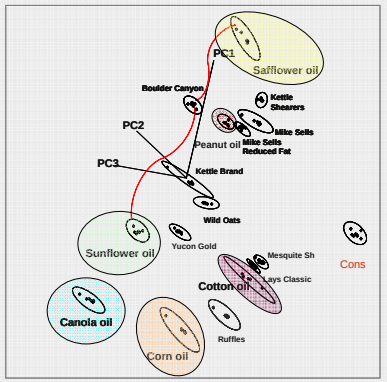


Fig 2. Classification model for Potato chip's oil

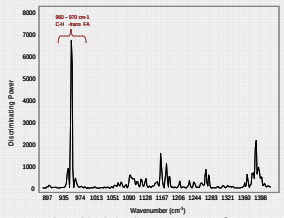


Fig 3. Discriminating power – trans fat

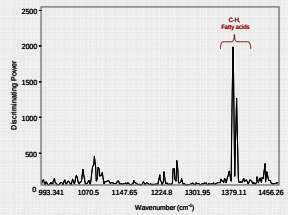


Fig 4. Discriminating power – oils

DISCUSSION

- The total fat content of the samples range from 18% to 45% and the moisture content range from 1.2% to 4%.
- The correlation coefficient (r) obtained for the prediction model of moisture were >0.97 and standard error of cross validation (SECV) < 0.3% for both NIR and MIR techniques.
- For the prediction model of fat, an r >0.96 was obtained and SECV values of 1.29% and 1.65% for NIR and MIR, respectively.
- Near infrared provided faster sample preparation and ease of use. Mid infrared was more laborious but it was useful for qualitative purposes. It was able to identify samples containing -trans fatty acids at 965 cm^{-1}.
- Classification of the potato chips based on the oil in which they were fried was possible due to the differences in the fatty acid composition (1300 to 1380 cm^{-1}) as shown in the discriminating power (Fig 4).
- The total time for the analysis was < 10 minutes compared to the 10 to 12 hours required with traditional methods.

CONCLUSIONS

- A fast, simple and accurate method for determination of moisture and fat content in potato chips was developed with NIR and MIR spectroscopy.
- Mid infrared identified samples containing -trans fatty acids at 965 cm^{-1}.
- Classification models developed based on Soft Independent Modeling of Class Analogy were able to differentiate the potato chips according to the type of oil in which the potatoes were fried.

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